Perfusion and Permeability MRI Biomarkers for Enhancing and Nonenhancing Components Predict Patient Survival in Newly Diagnosed Glioblastoma

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Purpose: Accurate prognosis of newly diagnosed glioblastoma would improve patient management. Although growing evidence suggests that advanced MR imaging techniques, such as dynamic susceptibility contrast (DSC) PWI and DWI may speculate on patient's survival, the fact is that MR imaging biomarkers' role prognosis in newly diagnosed glioblastoma remains unclear. Therefore, we retrospectively determined the usefulness of DSC, permeability maps, DWI parameters, and extensive battery of qualitative findings for contrast-enhancing lesion (CEL) and surrounding non-CEL in predicting newly diagnosed glioblastoma survival.

Material and Methods: Before treatment, 33 consecutive patients (22 men; mean age, 63 years) with histologically proven glioblastoma underwent 1.5T MRI (anatomical, first-pass DSC, and post-contrast T1-weighted sequences). We obtained volumes of interest for cerebral blood volume ratio, cerebral blood flow ratio, mean transit time (MTT), time-to-maximum, time-to-peak, permeability constant (k2), and ADC in CEL, NCEL, and contralateral tissue using Olea Sphere V.2.0 software (Olea Medical, La Ciotat, France). We used a recently proposed set of controlled MRI features called VASARI (Visually Accessable REMBRANDT[Repository for Molecular Brain Neoplasia Data] Images). Therefore, the following 26 MRI descriptors were used: major axis length, minor axis length, tumor location, side of lesion center, eloquent brain, enhancement quality, proportion enhancing, proportion NCET, proportion necrosis, cysts, multifocal or multicentric, T1/FLAIR ratio, thickness of CEL margin, definition of the CEL margin, definition of the NCEL margin, proportion of edema, edema crosses midline, hemorrhage, DWI characteristics, pial invasion, ependymal invasion, cortical involvement, deep WM invasion, NCET tumor crosses midline, CEL crosses midline, satellites, and calvarial remodeling. Patients were classified by survival: <6months and >6months. Surgery, radiotherapy and chemotherapy was considered complete treatment.

Results: Twenty patients (60.6%) survived <6months. Eleven (33.3%) underwent complete treatment. Survival groups differed in treatment (P=0.037), MTT-CEL (4.6±1.5 vs 5.5±1.2mL; P=0.043), k2-CEL (-30.22±90.12 vs -113.21±94.69; P=0.018), k2-NCEL (-20.22±34.06 vs -59.74±58.72; P=0.041), for <6 and >6months survival, respectively. k2-CEL best predicted survival at 6 months (AUC=0.738, 57.1% sensitivity, 83.3% specificity, 72.7% positive predictive value, 71.4% negative predictive value). k2-CEL and treatment yielded the best combined prediction of survival at 6 months (AUC=0.83, 64.3% sensitivity, 88.9% specificity, 81.8% positive predictive value, 76.8% negative predictive value).

Conclusions: Preliminary data suggest PWI and permeability parameters might predict survival in newly diagnosed glioblastoma. More specifically, MTT-CEL, k2-CEL, and k2-NCEL seem useful advanced MRI survival biomarkers.